In this paper, we focus on hidden period identification and the periodic decomposition of signals. Based on recent results on the Ramanujan subspace, we reveal the conjugate symmetry of the Ramanujan subspace with a set of complex exponential basis functions and represent the subspace as the union of a series of conjugate subspaces. With these conjugate subspaces, the signal periodic model is introduced to characterize the periodic structure of a signal. To achieve the decomposition of the proposed model, conjugate subspace pursuit with periodicity and energy (CSPPE) algorithm is proposed based on two different greedy strategies. The CSPPE is performed iteratively in two stages. In the first stage, the dominant hidden period is chosen with the periodicity strategy. Then, the dominant conjugate subspace is chosen with the energy strategy in the second stage. Compared with the current state-ofthe-art methods for hidden period identification, the main advantages provided by the CSPPE are the following: 1) the capability of identifying all the hidden periods in the range from 1 to the maximum hidden period Q of a signal of any length, without truncating the signal; 2) the ability to identify the time-varying hidden period with its shifted version; and 3) the low computational cost, without generating and using a large over-complete dictionary. Moreover, we provide examples and applications to demonstrate the abilities of the proposed two-stage CSPPE algorithm, which include hidden period identification, signal approximation, time-varying period detection, and pitch detection of speech.